ONLINE AND OFFLINE SIGNATURE VERIFICATION WITH PERFORMANCE EVALUATION

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ABSTRACT

In a variety of applications online and offline signature is being used. Signature of an individual is unique because each person signature has different physical and behavioural characteristics. But when a person duplicates our signature and misuses our signature then the problem arises. To differentiate and identified whether the given signature is by the concerned person or a forgery is the objective of the signature verification and identification system. Online and Offline signature verification and identification is a prominent area for research work. For online signature, it requires a special electronic signing device which gives data such as pen position, altitude angle and pen pressure at each and every step. Offline signature data was collected through images of scanned signatures. In this paper, we discuss what are the different techniques available for both online and offline signature verification and identification, steps to process signature verification and performance evaluation.

*KEYWORDS: Biometrics, Online, Offline, Handwriting, Signature & Performance Evaluation*

1. INTRODUCTION

Biometrics is the measurement of a human's distinctive physical and behavioural characteristics. The handwritten signature is comes under behavioural biometrics. Online and Offline signature verifications are significant methods to find whether a given signature is genuine or forged. It is very much necessary to avoiding forgery of documents in various legal, commercial and financial situations.

Biometric systems are working in two states like verification and identification, in the first step the system is to verify if the user is undeniably the same person who he or she claims an uniqueness and gives the biometric sample. In the second step, a user provides a biometric sample to identify among all that he or she enrolled in the system. Almost places a person manually done the verification, who is aware to the signature or by matching it with a few signature templates.

Signature verification techniques are classified into two types online and offline [1]. In an online approach for verification and identification purpose, handwriting speed and pen pressure are considered. In the second approach that is offline method [2], the signature written on the paper is converted into scanned images for verification and identification purpose. The verification and identification of handwriting signatures are more challenging and difficult in offline mode than online mode. Because in the offline mode we are using scanned images for verification in that time a lot of dynamic information is lost. Therefore online signature verification achieves more accuracy compare to offline signature verification. Even though, offline signature verification methods are more significant because they don't require any special processing devices when producing the

signatures [3].
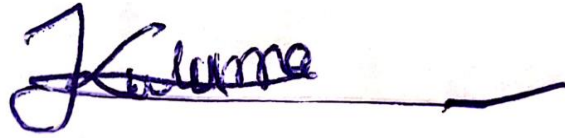
Figure 1: Sample of Offline Signature.

Figure 2: Sample of Online Signature.

2. LITERATURE REVIEW

Different online and offline signature verification methods are discussed in the literature review. Offline signature verification method introduced by L.Basavaraj and R.D Sudhaker Samuel [4] based on four speed stroke angle. From static signature images, it extracts the dynamic features and intensity is directly proportional to the speed of the stroke.

The system uses histogram and Hough transform algorithm for horizontal and vertical signature. The proposed system used local direction patterns based method for the offline signature verification [5]. For black and white static signatures verification, local directional patterns are more suitable. Signature samples and random forgeries are trained by using Support vector machine classifier and for testing purpose, random and skilled forgeries are used.

Deep learning based signature verification most kinds of pattern recognition problems in that signature verification also achieved great breakthrough in current years. For this method, more than one genuine reference signature samples are required for training the network [6][7][8][9]. Another proposed system train the model with small number of signature samples using a one class support vector machine classifier, with the concept of learning with small datasets [10]. Signature verification approach by Hafemann et al [11] based on Meta learning approach.

Two stage neural network classifier used for offline signature verification by H. Baltzakis and N.Papamarkos [12]. Another proposed system using neural networks introduced offline verification method based on fusion of grid and global features. These features are used to generate powerful features with 4.16% FAR and 7.51% FRR [13].

Hidden Markov Model is used for online handwritten signature verification by Shafiei [14]. The proposed system works based on variable length segmentation of signatures. The automatic signature verification method is used for online handwritten signatures, using both global and local features proposed by Kashi [15].

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3. STEPS TO PROCESS SIGNATURE VERIFICATION

For the implementation of signature verification techniques, five different steps are used.

- **Data Acquisition:** signatures are captured through Camera for offline signatures and online signatures are obtained using stylus, touch screen, or a digitizer. Afterword performs the various database management aspects like modification, deletion and training for the signatures and stored in the database.

- **Pre Processing and Noise Removal**: smoothing, normalization, segmentation and removing the noise like specious pixels from the offline signatures and signals from online signatures and then converting the gray scale images to binary images.

- **Feature Extraction**: global and local features are extracted from the signatures. Global features like height, width, pressure region, black pixels area, horizontal and vertical projections of the signature images. Baseline, edge points and number of cross, slant, run lengths etc. Local features are the same as global features except each feature are calculated for number of grids that the signature has been divided.

- **Learning:** mean and standard deviation are calculated for each extracted feature. If we use more training samples higher accuracy is obtained.

- **Verification**: the various features obtained from the signature image are verified with the features stored in the database for recognising the signatures. If the signatures are matched the database signatures it is accepted otherwise rejected and it as a forgery.
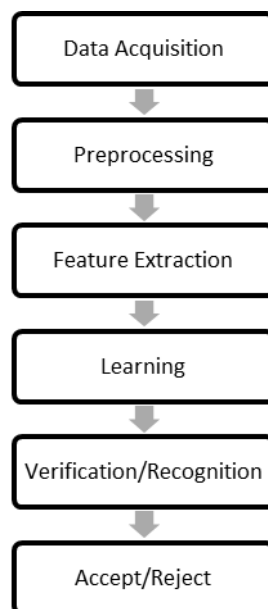
Figure 3: Steps to Process Signature Verification.

4. PERFORMANCE EVALUATION OF SIGNATURES

The performance and the result of the signature verification system is measured using False rejection Rate (FRR), False Acceptance rate (FAR), Total Error rate (TER) and Equal Error Rate (EER).
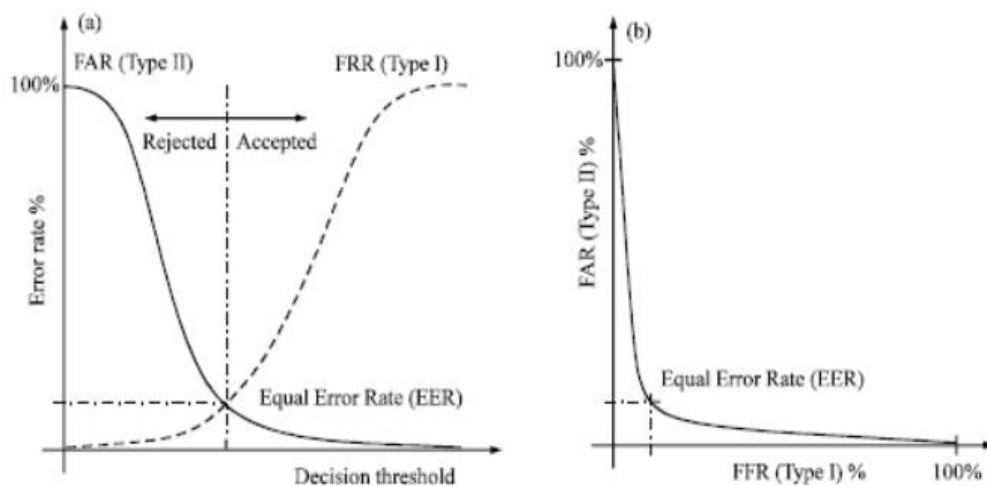
Figure 4: Curves of FRR, FAR and EER.

- **False Rejection Rate:** it is also known as Type –I error. It is defined as the percentage of authorised signature rejection occurs in the identification instances. It can be determined for each individual features.

- **False Acceptance Rate:** The percentage of non-authorised person is accepted as authorised s known as False Acceptance rate or it is also called Type II Error. It is the ratio of number of false acceptance to number of identification attempts.

- **Equal Error Rate:** the percentage of FAR is equal to the percentage of FRR is called Equal Error Rate. To evaluate the performance of signature verification EER must be adopted. For better performance EER value must be smaller.

5. CONCLUSIONS

Offline and online signature verification is an extremely potential field for research. In current years to increase security and to avoid forgeries signature verification techniques are accepted on both legal and societal levels. In this paper, we provide information about offline and online signature verification techniques, steps to process the signature verification and performance evaluation of signatures.

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